

The European Commission's science and knowledge service

Joint Research Centre

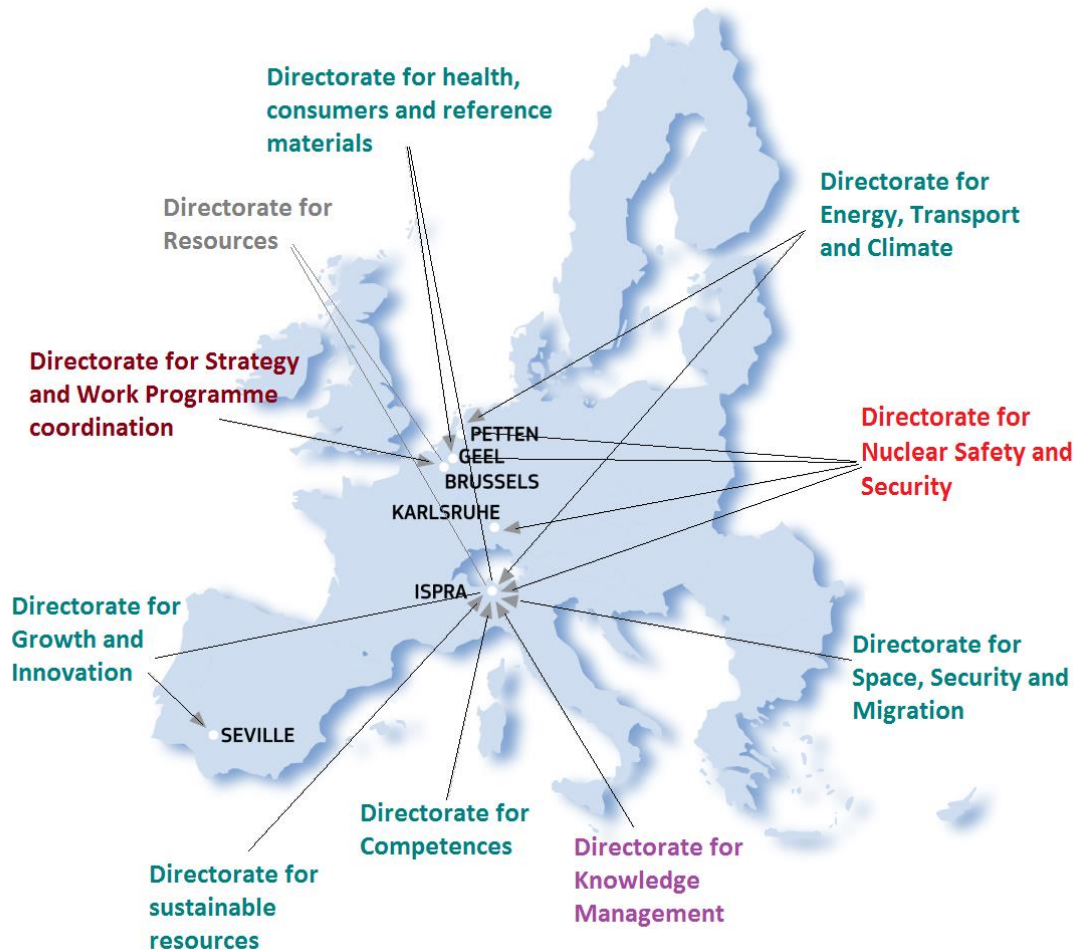
JRC Activities in nuclear safety, security and safeguards

Euratom Coordination Unit

EC/JRC



JRC at a glance



The Vision:

To play a central role in creating, managing and making sense of collective scientific knowledge for better EU policies.

The Mission:

As the scientific and knowledge service of the Commission our mission is to support EU policies with independent evidence throughout the whole policy cycle.

- Established 1957
- **5 locations**
- **around 3000 staff**

High-level objectives for JRC EURATOM Research and Training Programme (2014-2018)

- 1.– Improve nuclear safety including, fuel and reactor safety, waste management and decommissioning, and emergency preparedness.**
- 2.– Improve nuclear security including: nuclear safeguards, non-proliferation, combating illicit trafficking and nuclear forensics.**
- 3.– Raising excellence in the science base for standardisation.**
- 4.– Foster knowledge management, education and training.**
- 5.– Support the policy of the Union on nuclear safety and security and the related evolving Union legislation.**



JRC's Euratom Activities

Safety of Generation II and III nuclear reactors



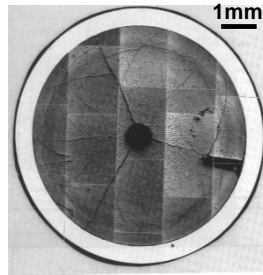
Nuclear safeguards and non-proliferation



Nuclear Security CBRNE

Partnership and support to Member States, Stakeholders; international cooperation

Safety of Generation IV nuclear reactors



Nuclear decommissioning



Nuclear Science Application

Nuclear Emergency Preparedness and Response



Radioactive waste management

Knowledge management, education & training, R&D infrastructure

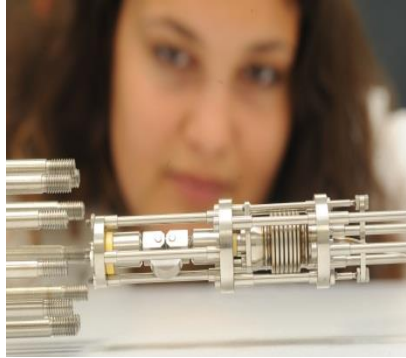


Nuclear safety

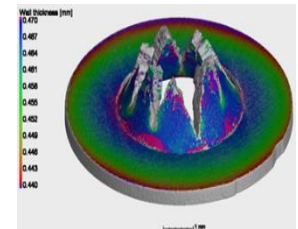
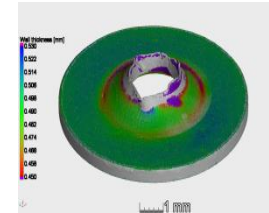
Nuclear Reactor Safety

Advanced Mechanical Test Methods – Materials

Creep-Fatigue or Stress Corrosion Cracking at high T in corrosive environments (supercritical water, liquid lead, gas)



Small Punch Tests: Ductile vs. brittle fracture



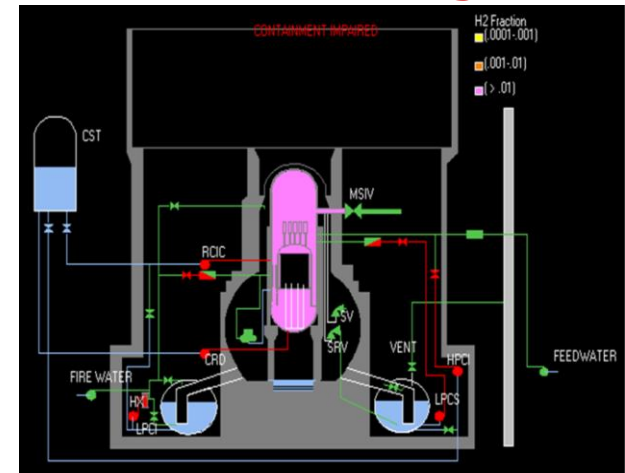
European Clearinghouse on OEF

Nuclear regulators of EU Member States having NPPs and Switzerland + Ukraine are participating in the European Clearinghouse

International cooperation through IAEA and OECD/NEA



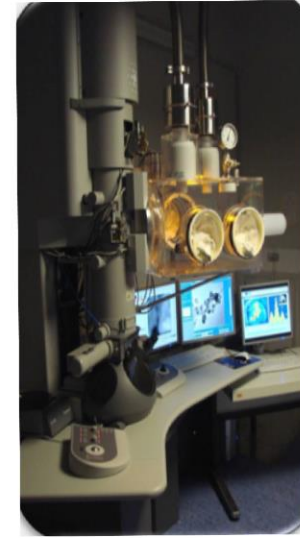
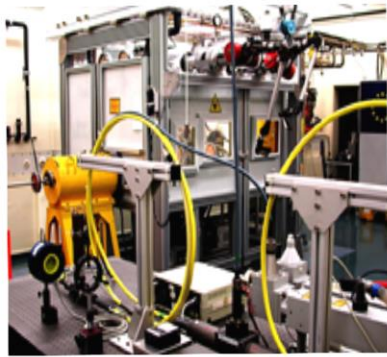
Accident modelling



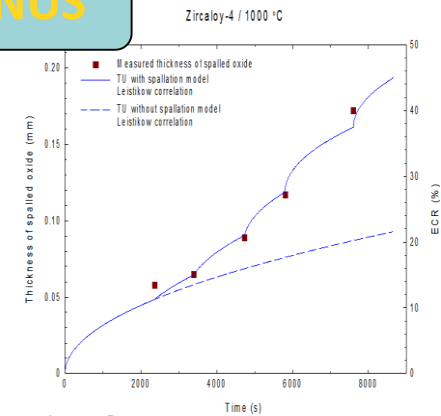
Station Blackout scenario in a BWR Mark I (MAAP)

Nuclear Fuel Safety

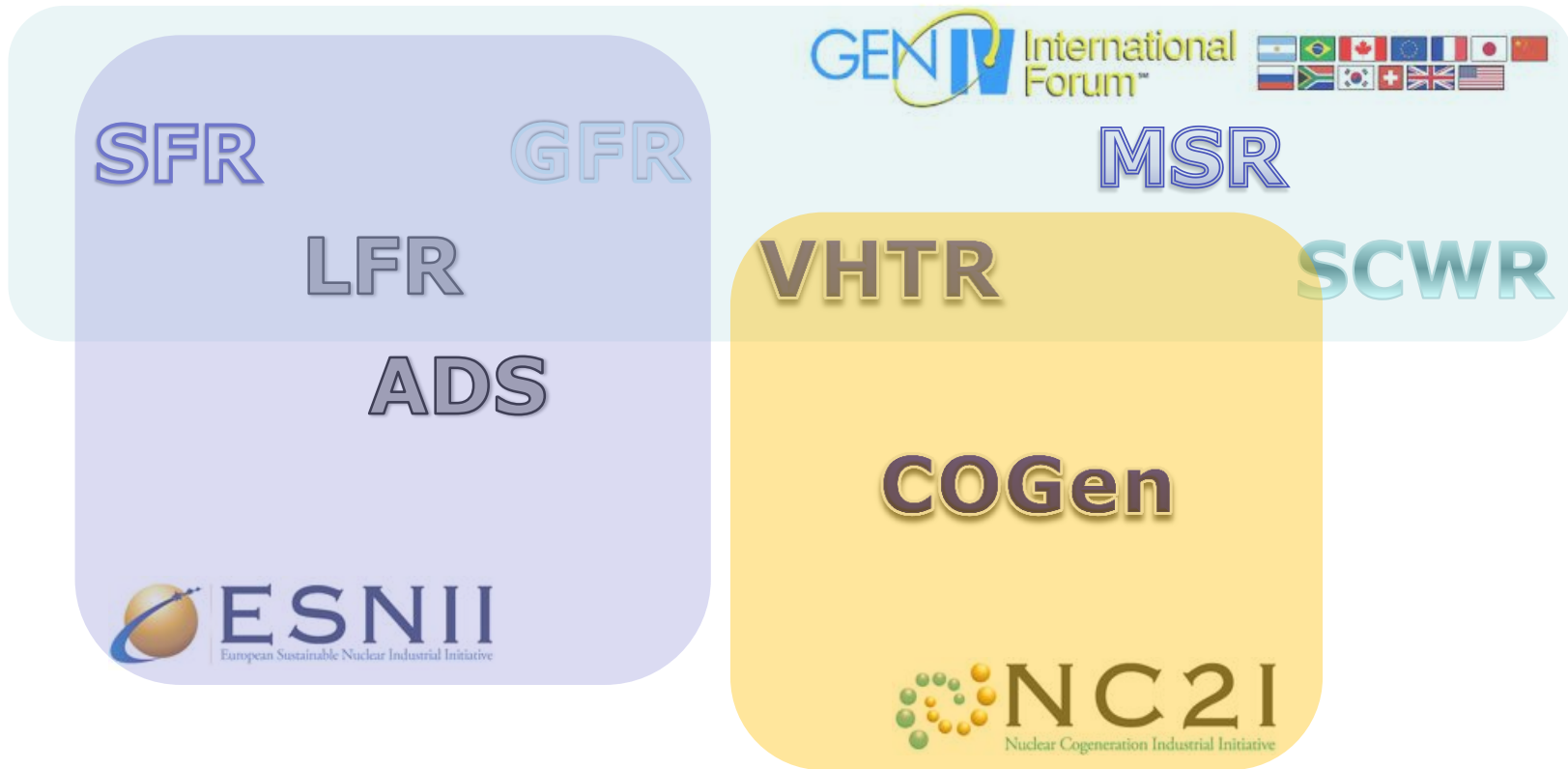
unique infrastructure



TRANSURANUS



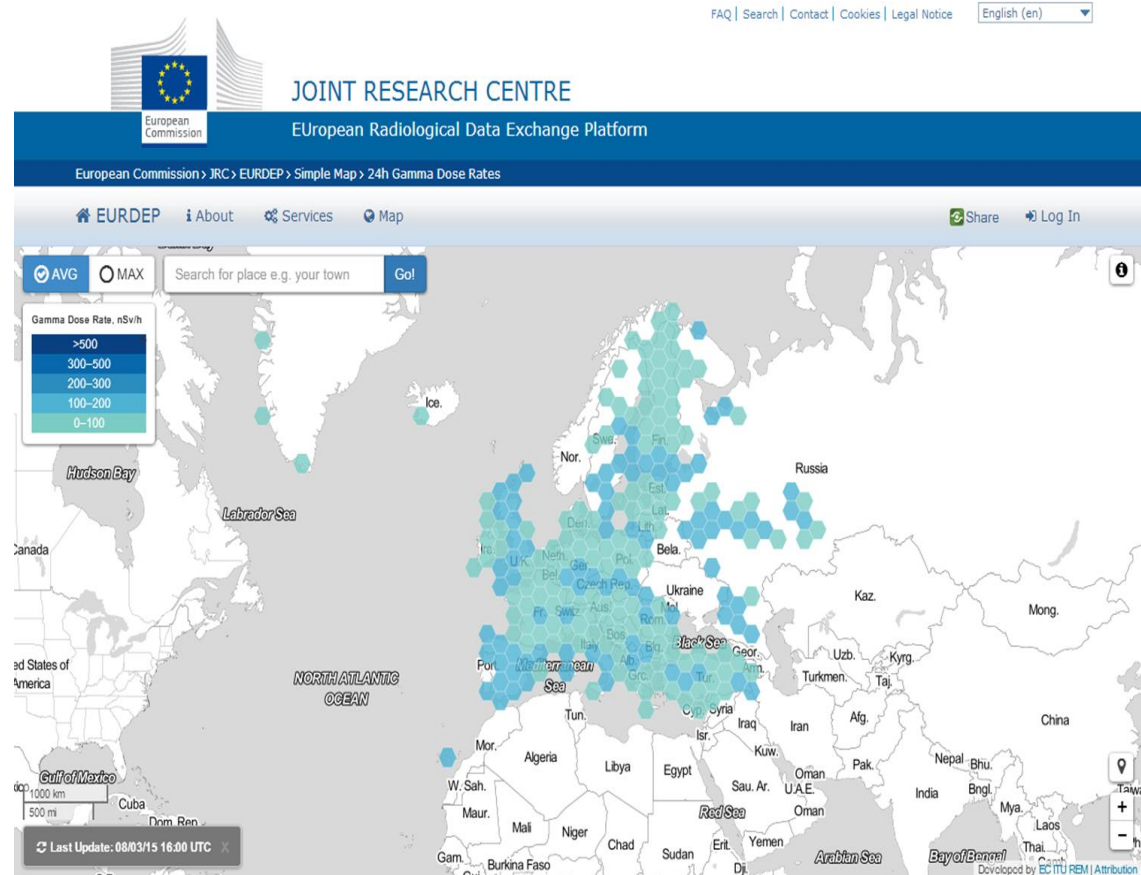
GENERATION IV SYSTEMS





Current status

- Internationally recognized standard format for radiological data;
- Network (39 European countries with > 5000 stations participating);
- daily and hourly transmissions, mostly γ -dose rates;
- Raw data available at 2 mirror-sites (Ispra, Italy – Freiburg, Germany)
- Web-site to view and download data.
- MoU underpins the intent to continue sending monitoring data during an emergency (i.e. important for non-ECURIE countries).



<http://eurdep.jrc.ec.europa.eu>

***Spent fuel, radioactive
waste management and
decommissioning***

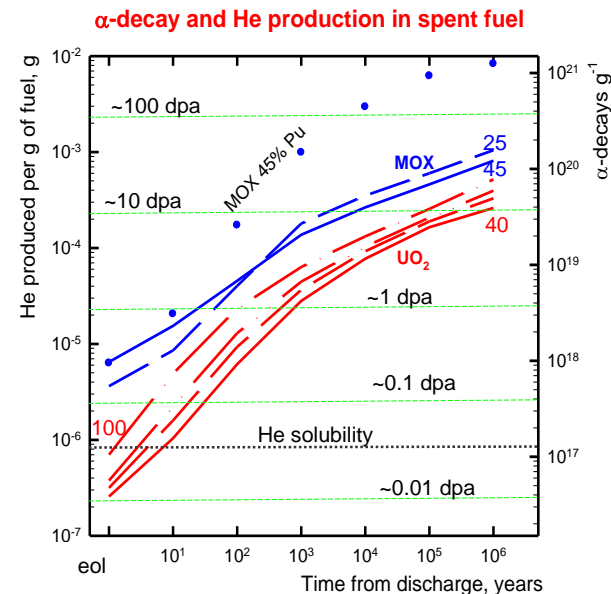
Waste (spent fuel) safety studies

assess SF/wasteform ability to fulfil its expected function over long-term

(Extended) Storage

radionuclides **containment**,
rod **retrievability** (≥ 100 y?)

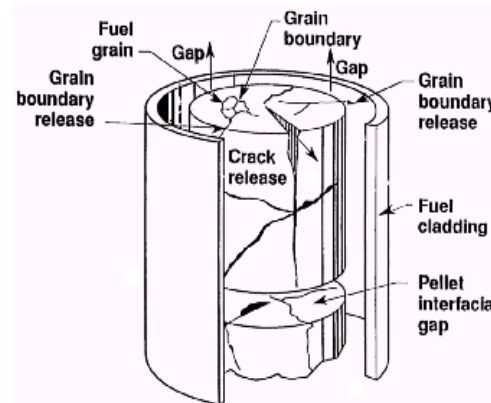
spent fuel rod: decay damage,
He accumulation effects in SF;
cladding (hydrides)



Geologic Disposal

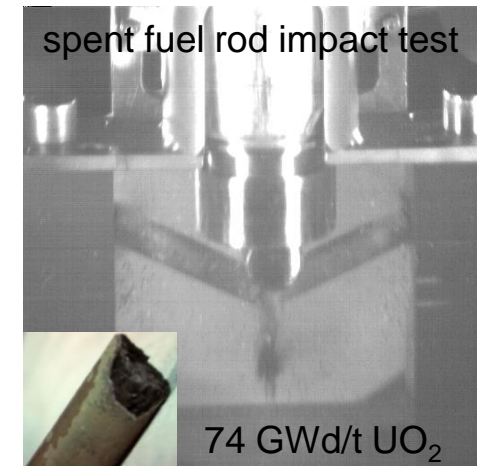
reduce **uncertainties** on
release of long-lived
radionuclides over an *open-
ended disposal timescale*

radionuclides “Source Term”,
“Instant Release”;
matrix corrosion: effects of
environment and spent fuel
properties



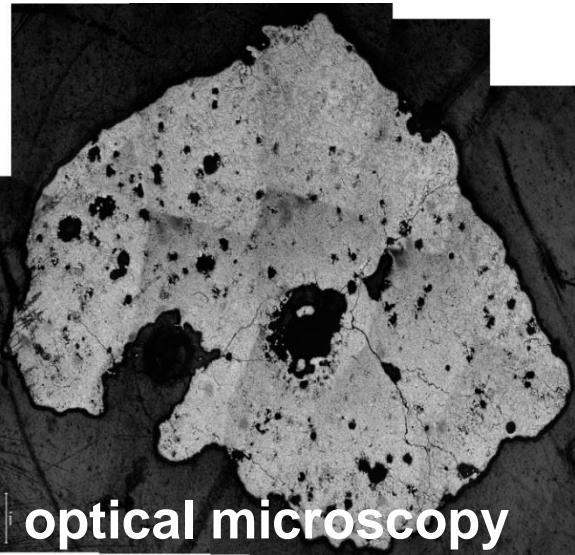
Accident conditions

**pools, handling, transport,
storage, retrieval:**
mechanical load, impact
resistance; corrosion, loss of
cooling; damaged SF, debris
properties

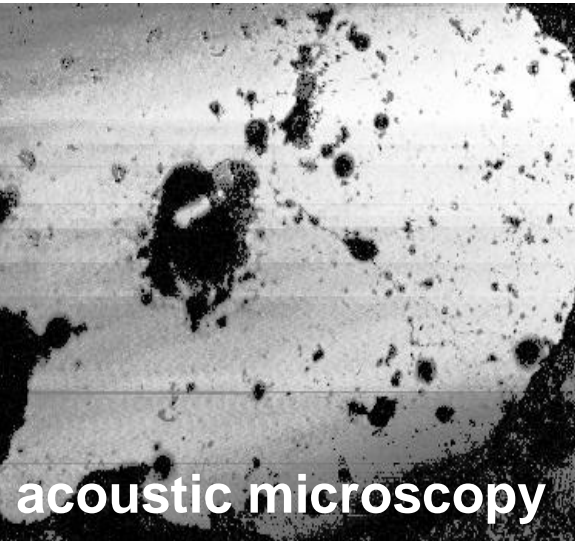


Convey experimental data into models and codes (predictions)

Waste management and decommissioning



**TMI-2 molten core sample
before and after >20 y storage**



acoustic microscopy

Investigations on damaged fuel/corium properties and ageing processes relevant for debris retrieval use real corium samples from TMI2 and Chernobyl as well as corium analogues synthesized in house;

- mechanical properties of corium in view of removal and conditioning;
- corrosion behaviour in water and other aqueous media relevant for emergency cooling, spent fuel pools and other scenarios (emphasis on post-Fukushima).

A dedicated facility was constructed and used to condition and package surplus nuclear material from its ISPRA and Karlsruhe sites for transport to the USA in the frame of the Global Threat Reduction Initiative.

→ experience applicable to conditioning of legacy waste

JRC Decommissioning and Waste Management Programme

Ispra FARO-ECO by
2019



Ispra STRRL old liquid
waste facility by **2022**



Reactor ISPRA 1



Ispra LCSR Hot Cells
complex by **2025**



Ispra Cyclotron by **2025**



Ispra ESSOR Nuclear Area by **2028**



JRC-Karlsruhe
Facilities for research for the nuclear fuel cycle (hot cells and glove boxes)

JRC-Geel
Accelerators for neutron physics
Laboratories

JRC-Petten
High Flux Reactor and
annexed laboratories

Nuclear safeguards and security

Nuclear security and safeguards at JRC

Effective and Efficient Safeguards



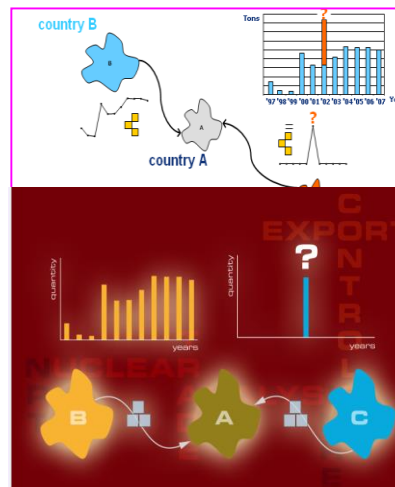
- Nuclear material measurements
- Reference materials
- Containment & Surveillance
- Process monitoring
- On-site laboratories

Verification Absence of Undeclared Activities



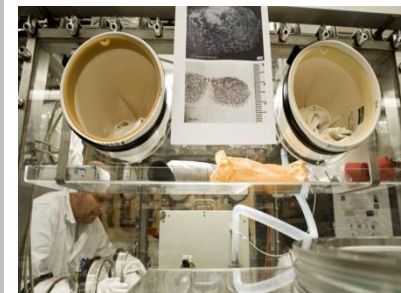
- Trace & particle analysis
- In-field tools for investigative inspector
- Reference materials

Nuclear Non Proliferation



- Export control
- Trade analysis
- Non-proliferation studies

Combating Illicit Trafficking



- Equipment development
- Testing & validation
- Nuclear forensics
- Nuclear preparedness
- National response plan
- CBRN, IfS, ...

Nuclear safeguards and non-proliferation

On-site Labs at reprocessing plants

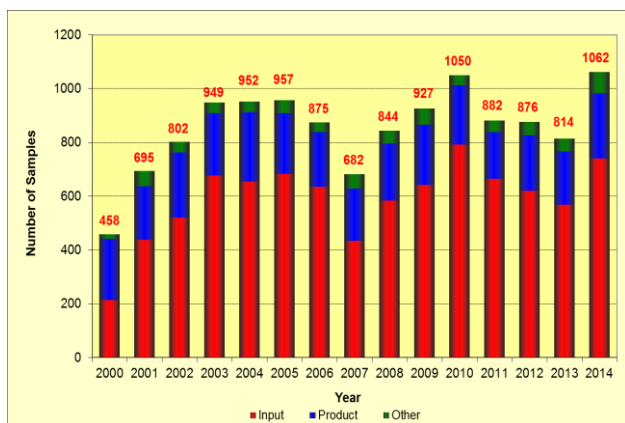
- Scientific support to Euratom safeguards implementation
- equipment developments
- Sample analysis



OSL Sellafield (UK)



OSL La Hague (F)

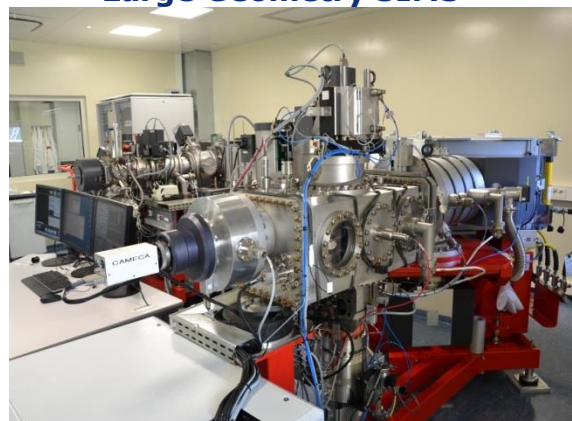


Undeclared Nuclear Activities

Analysis of small aerosol particles in dust from environmental/swipe samples can provide information on the nuclear materials handled in the facility

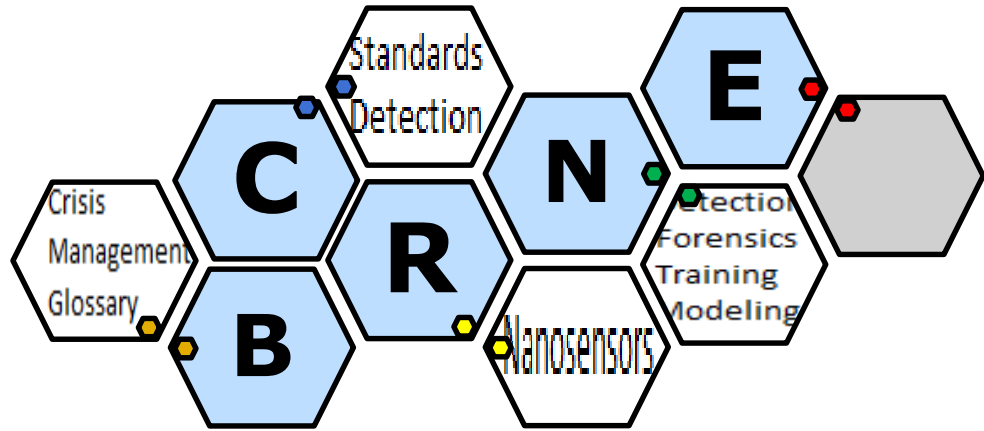
- LG-SIMS lab under ISO17025
- Continuous R&D effort to improve analytical capabilities

Large Geometry SIMS



CBRNE security

CBRNE - Chemical, Biological, Radiological, Nuclear, and Explosives



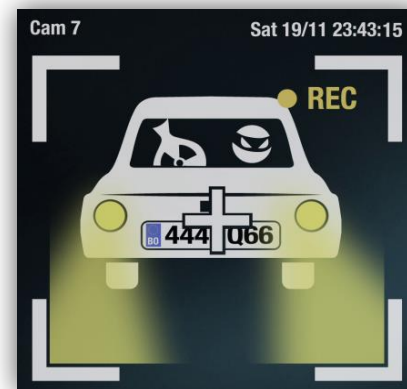
- Performance assessment of RN detection equipment. Commercial equipment testing.
- Development of a new method for detection of Special Nuclear Materials with a high potential for practical applications
- Identification of high confidence nuclear forensics signatures.
- Urban Dispersion International Evaluation Exercise.
- RN support to the EU CBRN Centres of Excellence Initiative.

Apex Europa High level scenario-based radiological and nuclear security exercise

Involving fictional states but in the context of the EU specific characteristics

Scenario included elements of radioactive source security, namely

- **Physical protection**
- **Transport**
- **Detection**
- **Emergency preparedness**
- **Forensics**



Standardisation

Facilities for nuclear measurement standards research



GELINA

neutron time-of-flight facility for high-resolution neutron measurements



MONNET

tandem accelerator based fast neutron source



RADMET

laboratories for standardisation of radionuclide activity



METRO

nuclear reference material and measurement facility



TARGET

nuclear target preparation laboratories



low-level gamma-spectrometry laboratory at
HADES

Nuclear Data

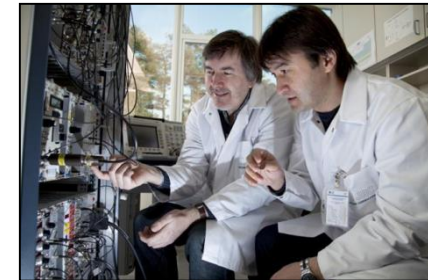
JRC-Geel major European provider of nuclear data and standards for nuclear energy applications

- Neutron cross-section measurements for safety assessments of present-day and innovative nuclear energy systems.



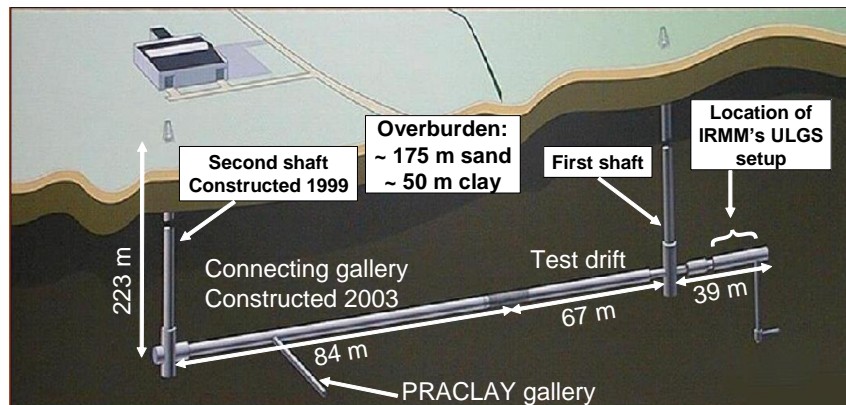
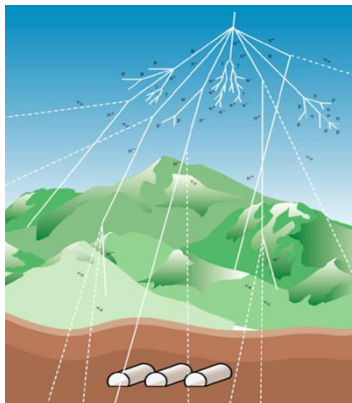
Primary (and secondary) standardisation laboratory of radioactivity

- 4π β - γ coincidence counting systems
- 4π γ counting, 4π β - γ sum counting, 4π e^- , β , γ , X-ray counting
- radiochemistry laboratory



Underground ultra-low level radioactivity laboratory in HADES

- Measurement of water samples to determine ^{134}Cs and ^{137}Cs in ocean currents
- Measurement of $^{110\text{m}}\text{Ag}$ and Cs in suspended particles for **environmental studies**
- Certification of **brown rice reference materials**



(mBq/kg)

Technical Support to EU policies

Support to Nuclear Safety Policy inside the EU



Objectives/rationale

Direct technical support to EU policy implementation:

- ❖ Euratom Treaty obligations
- ❖ Nuclear Safety Directive
- ❖ Nuclear Spent Fuel & Radioactive Waste Directives
- ❖ *Basic Safety Standards Directive*
- ❖ Other demands from EC to supplement previous support (Shipment directive, Decommissioning programmes,...)



EU International Nuclear Safety Policy

EU International
Nuclear Safety Policy

Support to Nuclear Safety Policy outside the EU

1990 - 2006

TACIS / PHARE

2007 - 2013

INSC 524 M€
/ IPA

2014 - 2020

INSC 225 M€



Expert contribution to nuclear safety improvement projects financed by EC and implemented in candidate and third countries worldwide:

- Regulatory authorities
- NPP owner/operators (reducing)
- safe decommissioning, RW management and remediation of contaminated sites
- Emergency preparedness
- <https://nuclear.jrc.ec.europa.eu/tipins/>

(Ukraine, Belarus, Iran, Armenia, Turkey, ...)



Training and Tutoring:
in Europe and regionally
> 1000 students
> 40 countries



European
Commission

EU "External" Security Strategy

Instrument contributing to Stability and Peace (IcSP):

€ 2.3 billion

IcSP - art. 5 (EUR 478 million)

Global and trans-regional and emerging threats -

- Fighting Organised Crime (Human Beings, SALW, Drugs, Money Laundering, Cyber crime);
- Protecting Critical Infrastructures (Maritime, Aviation, Cyber Security);
- Countering Terrorism (Horn of Africa, Pakistan, Sahel...);
- Security threats emanating from Climate Change;
- **CBRN Risk Mitigation (regional Centres of Excellence, Export Control; Bio safety; Dual Use containment...).**

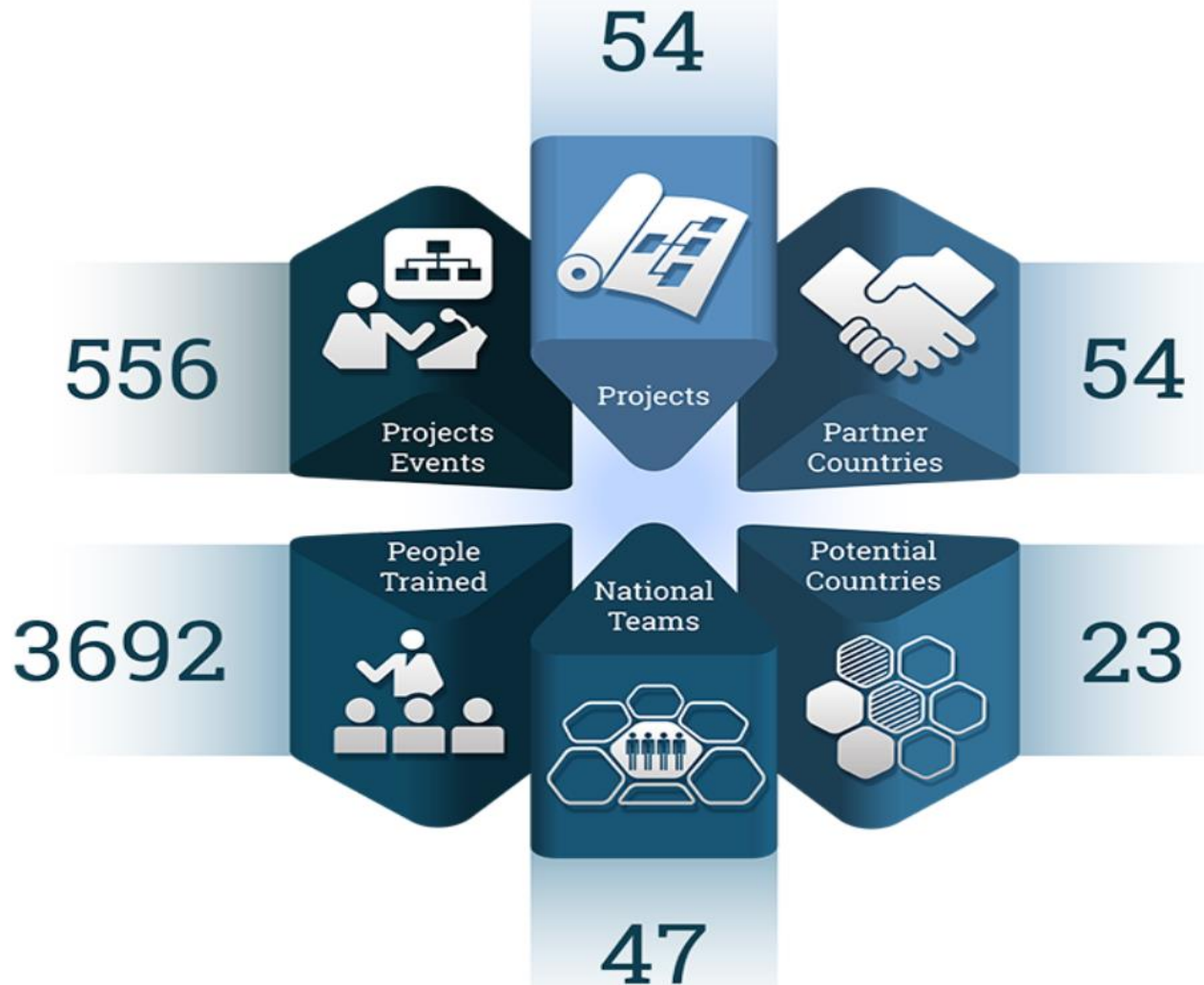


Funded by the European Union

EU CBRN Centres of Excellence initiative



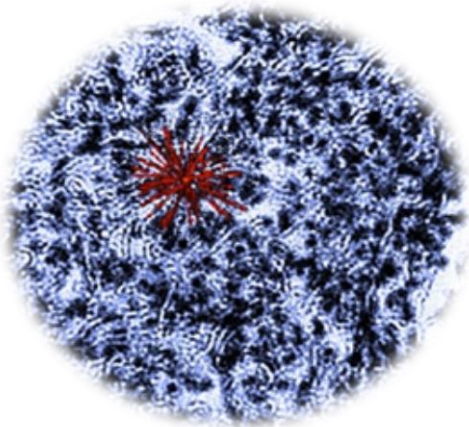
CBRN
Centres
of Excellence
An initiative of the European Union



Nuclear science applications

Nuclear science applications

- **Accelerator based nuclear measurements and associated applications**
- **Basic properties of radionuclides and associated applications**
- **Developments in the field of non-energy applications of nuclear technology**
 - Medicine
 - Space (heat and electricity)

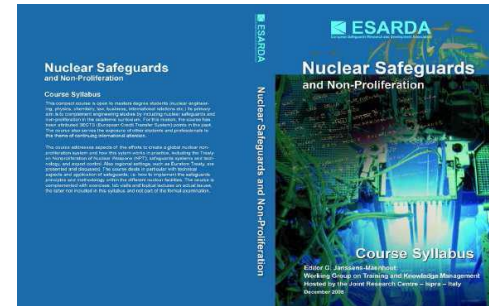


***Education and training.
Open access to JRC nuclear
facilities***

Nuclear education and training

- **Nuclear safety**
- **Nuclear security**
- **Nuclear data measurements**
- **Decommissioning and waste management**
- **Nuclear safeguards and non-proliferation**

European Learning Initiatives in Nuclear Decommissioning and Environmental Remediation (ELINDER)



European Safeguards Research and Development Association (ESARDA)



Training for EURATOM and IAEA inspectors

8th edition of the
International Summer School
on Nuclear Decommissioning
and Waste Management

*Parallel 1st Workshop on Planning R&D
towards Geological Disposal*

Auditorium, Bldg. 58c
JRC-Ispra, Italy

12-16 September 2016

Organized by:



Supported by:



**International summer schools
RW management and decommissioning
Nuclear resonance analysis**

...



European Nuclear Security Training Centre (EUSECTRA)



<http://ehron.jrc.ec.europa.eu/>


JOINT RESEARCH CENTRE
 Institute for Energy and Transport (IET)

European Commission JRC
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Report on Nuclear HR and E&T situation in European enlargement and integration countries




Top down workforce demand from energy scenarios: Sensitivity analysis

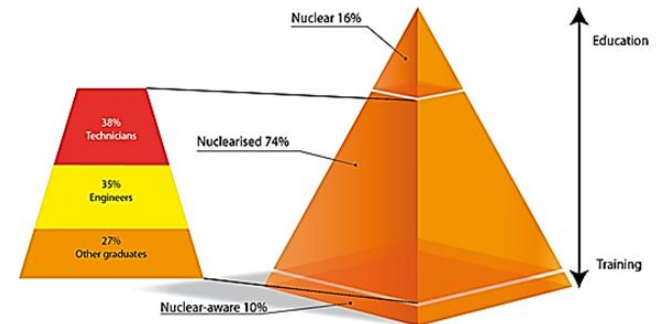
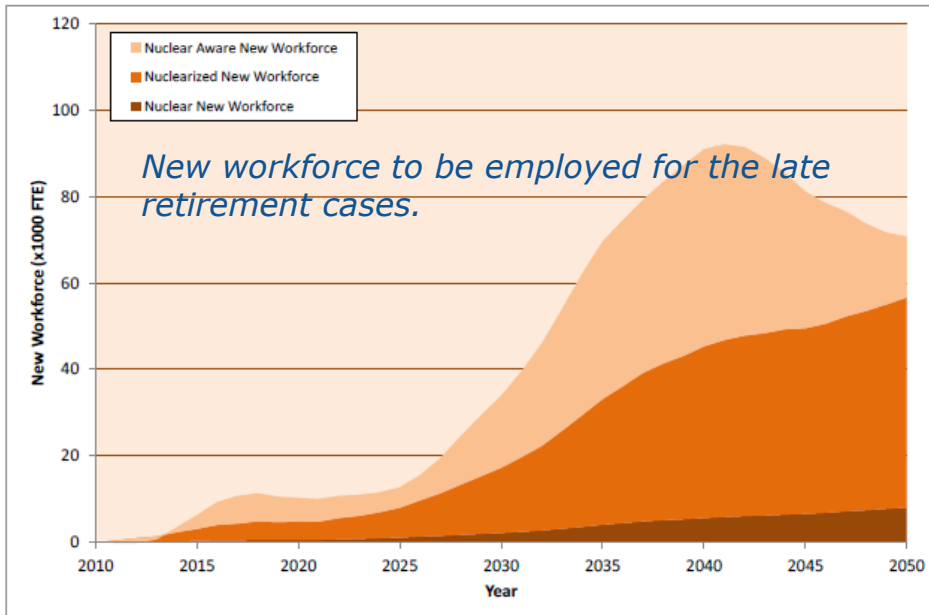
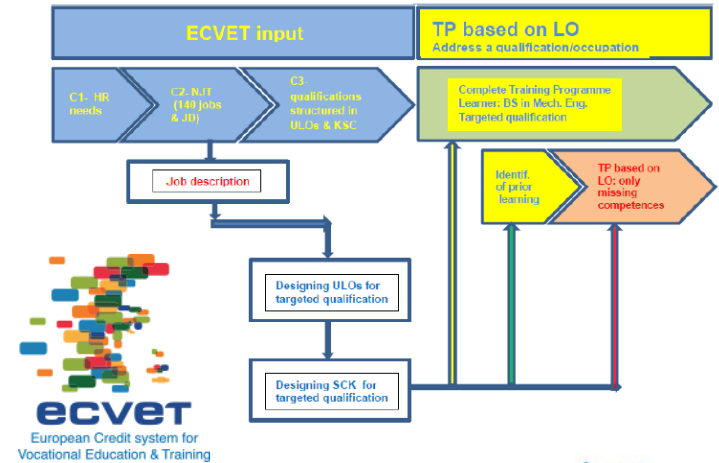
Post Fukushima Analysis HR & Supply

Influence of Long Term Operation

Training Courses
 Teleperm Xs-Special
 GERMANY Operation and Safety of PWRs
 FRANCE Nuclear Reactor Theory
 BELGIUM PD621 Grade 91 and other Creep strength Enhanced Ferritic Steels
 SPAIN PD634 Comparison of Quality Assurance Management
 ITALY

Search

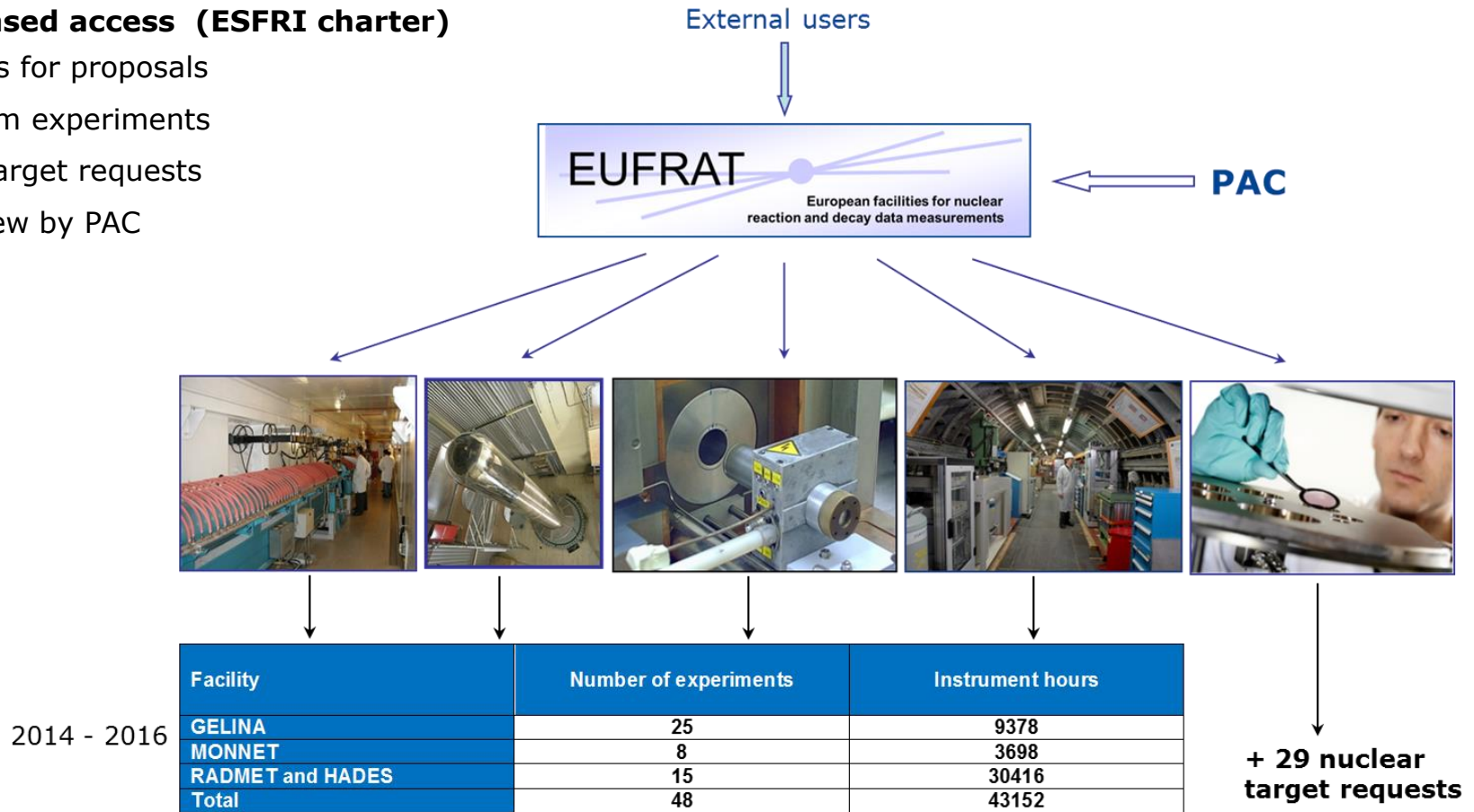
[more](#)



Open Access to nuclear facilities

→ quality-based access (ESFRI charter)

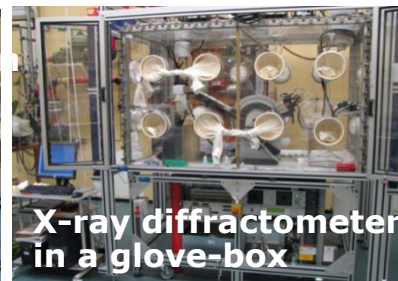
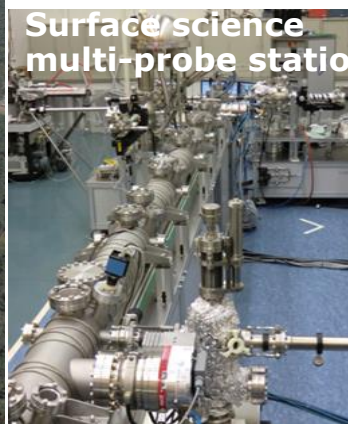
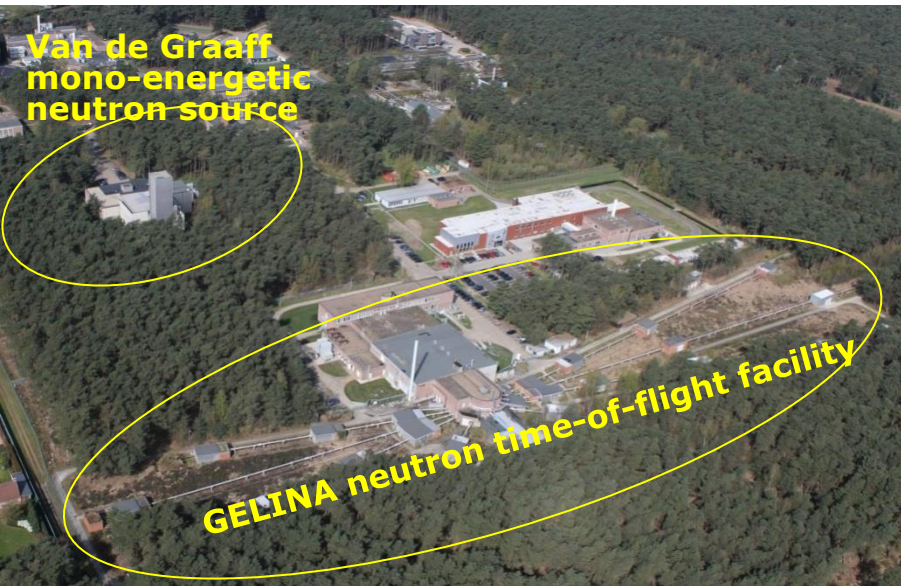
- Open calls for proposals
- Short-term experiments
- Nuclear target requests
- Peer review by PAC



Mandate: EURATOM Treaty article 6c

' To encourage the carrying out of research programmes ... the Commission may place installations, equipment or expert assistance at the disposal of Member States ...'

Open Access to nuclear facilities



Nuclear data



access to JRC infrastructure for handling transuranium materials,

EUF **RAT**

European facilities for nuclear reaction and decay data measurements

USERLAB

ACTINIDE USER LABORATORY

International Cooperation and Coordination

- **IAEA, NEA/OECD**
- **GICNT, UNSC 1540 Committee, GP**
- **Border Monitoring Working Group, Nuclear Smuggling International Technical WG**
- **US-DoS, US-DoE, US-DNDO**
- **Japan JAEA, China, Canada,...**
- **CBRN CoE partners**

Conclusions

- *highest standards of safety, security, waste management and non-proliferation.*
- *maintains technological leadership in the nuclear domain, so as not to increase energy and technology dependence"*
- *....the world's safest nuclear generation, is central to the aim of turning the Energy Union into a motor for growth, jobs and competitiveness*

This implies:

continued investment on:

***Research
Training/education,
Nuclear research infrastructure
Cooperation***

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